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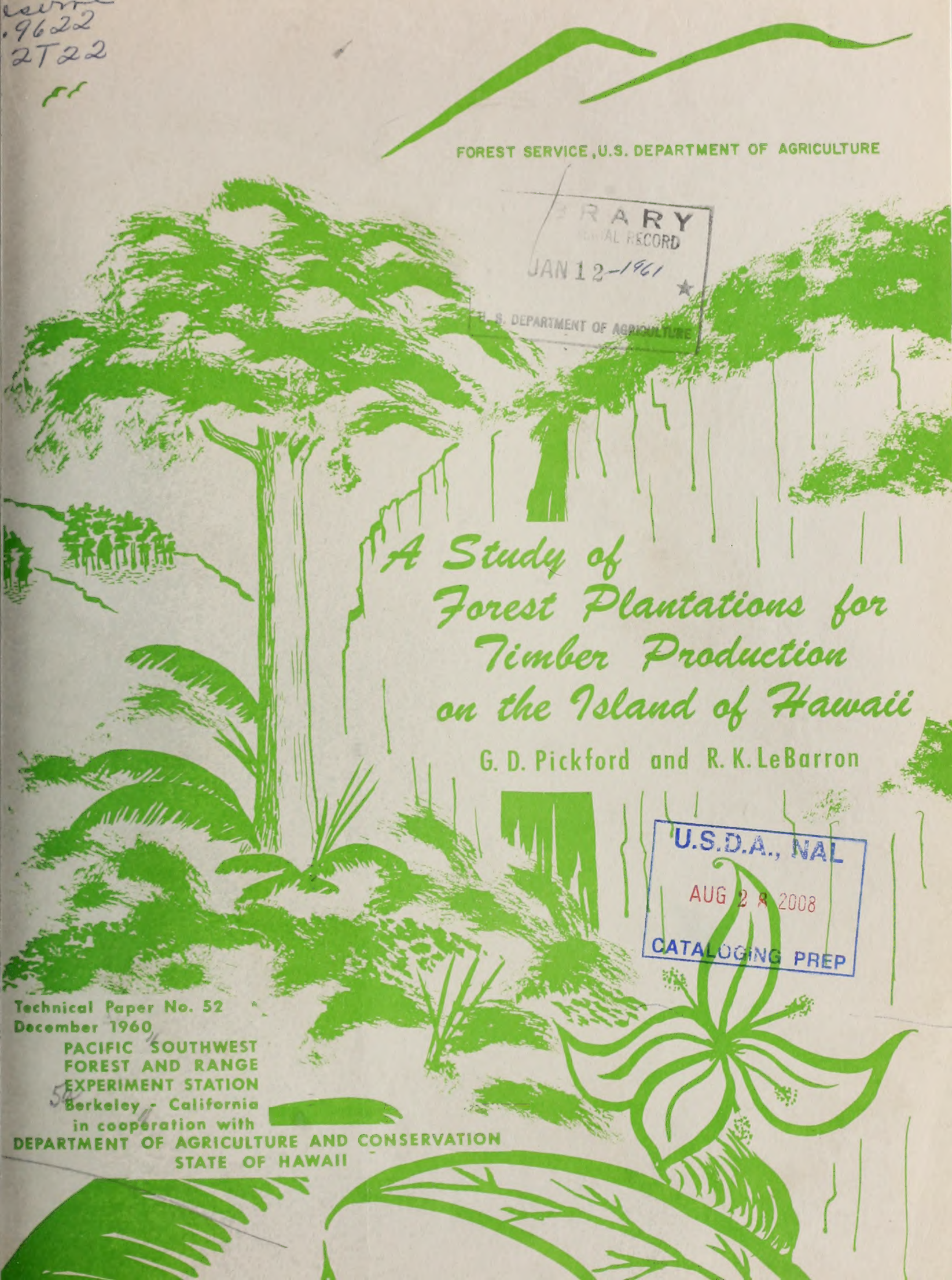

A Study of Forest Plantations for Timber Production on the Island of Hawaii

G. D. Pickford and R. K. LeBarron

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A STUDY OF FOREST PLANTATIONS FOR TIMBER PRODUCTION ON THE ISLAND OF HAWAII

By
G. D. Pickford and Russell K. LeBarron

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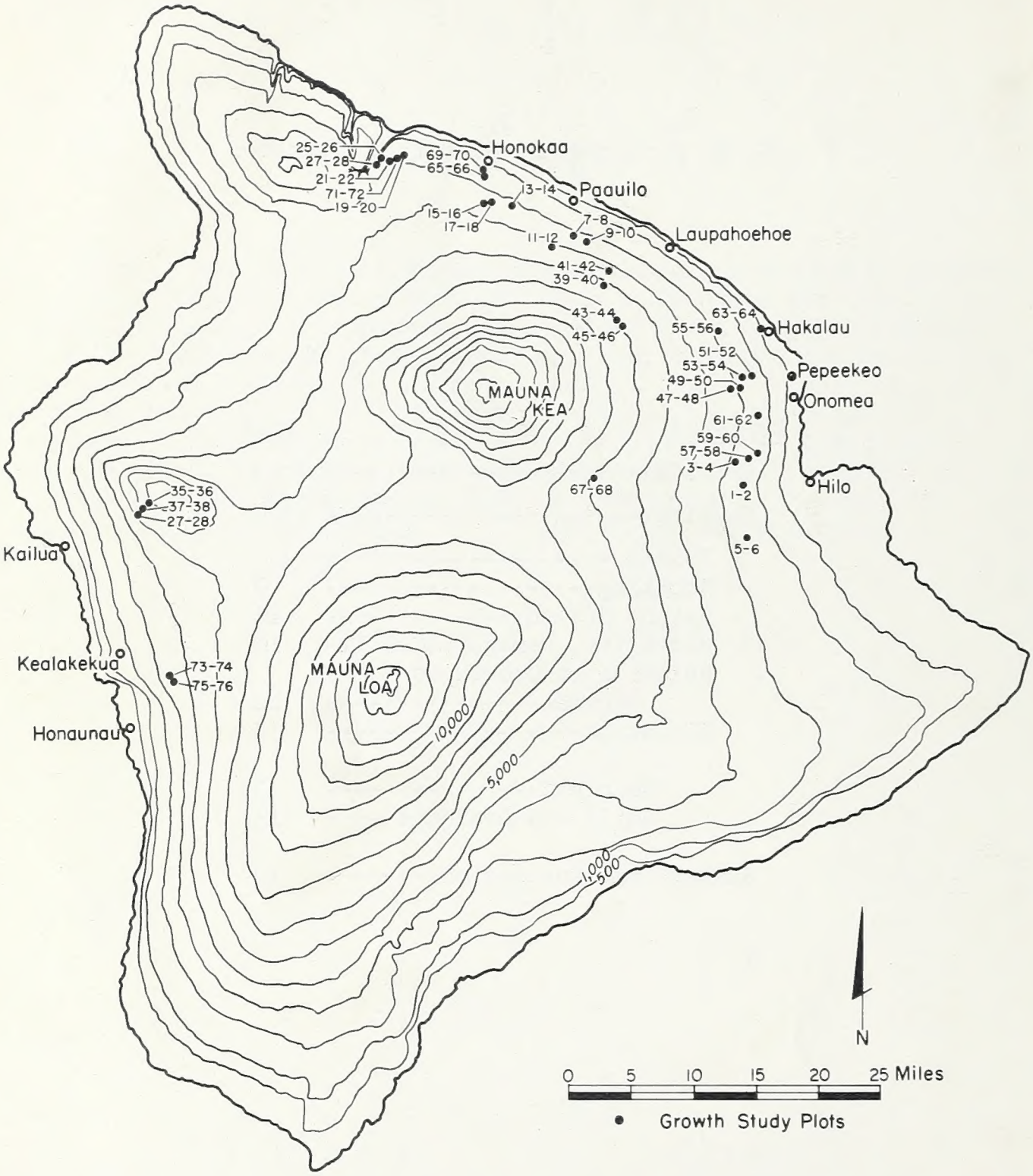

Figure 1.--Map of Hawaii showing location of growth study plots. 1960.

A STUDY OF FOREST PLANTATIONS FOR TIMBER PRODUCTION ON THE ISLAND OF HAWAII

By
G. D. Pickford and Russell K. LeBarron[1/]

This report describes a study of the growth of four important kinds of planted trees, swampmahogany eucalyptus, (Eucalyptus robusta), flooded-gum eucalyptus, (Eucalyptus saligna), tropical ash, (Fraxinus uhdei), and Australian red-cedar (Toona ciliata var. australis) on the island of Hawaii. It was conducted under the auspices of the Hawaii Department of Agriculture and Conservation to collect information on the suitability of these species for an expanded program of forestation. The enlarged forestation program emphasizes the growing of timber for forest products as an additional economic asset for the island.

The primary objectives of the study were to determine the volume growth in planted stands 20 years or more in age, and to evaluate the adaptability of the four species to various growing conditions.

The principal finding from the study is the remarkably high volumes of sawtimber that have been produced in very short periods:

Eucalyptus robusta up to 130 thousand board feet per acre at 38 years;

Eucalyptus saligna up to 94 thousand board feet per acre at 30 years;

Fraxinus uhdei up to 38 thousand board feet per acre in 32 years; and

Toona ciliata var. australis up to 29 thousand board feet per acre in 25 years.

In one location a younger stand of E. saligna showed even higher annual growth rate than any of the above.

Although average yields are substantially lower than the volumes cited above, these figures give an indication of the great productive capabilities of the land. Under intensified management, it is conceivable that even these volumes can be exceeded.

1/ The authors are Forest Ecologist, Hawaii Department of Agriculture and Conservation, Hilo, Hawaii, and Forester, U. S. Forest Service, Berkeley, California, respectively.

Swampmahogany eucalyptus

102, 000 board feet per acre

Age 38 years

Plot 58

The two eucalypts generally had straight, well-formed central stems or boles. The merchantable portions of the stem of the ash and red-cedar, however, were relatively short and heavily branched. This poor form reduces both volume and quality of sawtimber products. Perhaps it can be improved by cultural practices, such as planting the trees closer together followed by thinning, or by using genetically superior strains. This problem should receive further study but is outside of the scope of the investigation reported here.

METHODS

Locations for field examination were obtained from planting records in the office of the Division of Forestry in Hilo. After stands had been found on the ground, two 1/10-acre samples were selected for measurement in each timber stand. These samples were selected on the basis of having best available uniformity in stocking and best possible survival within the spacing that was employed when the trees were planted. In many instances the original spacing had been quite wide; for example 20 feet by 20 feet in the ash and red-cedar. The eucalypts were spaced more closely, mostly from 8 feet by 10 feet to 10 feet by 12 feet.

On each sample plot, all trees live and dead over 4.5 inches diameter breast high (4.5 feet above ground) were recorded. Measurements included d.b.h. on all trees and number of merchantable logs (16 feet 3 inches) on trees larger than 10.9 inches d.b.h. Live trees were classified as culls if they did not contain at least a merchantable 8-foot butt log, or if less than 50 percent of the total volume was merchantable. For trees with very short merchantable stems or multiple stems, the actual log lengths and diameters were estimated and tallied on the spot. This occurred with the majority of ash and red-cedar trees. On each plot, the average height of dominant trees was determined by measuring at least two.

For each stand, the following descriptive information was recorded: general location (see map, fig. 1), year planted, elevation, percent and direction of the slope, average annual rainfall, general soil notes, such as texture and drainage, original spacing of trees, survival percent, and stand thrift. A representative view was photographed at each plot.

During the course of the field work, sample trees were measured to determine Girard form class to be used later in conjunction with a tree volume table to determine board foot volume. About 50 trees each of the ash and red-cedar were measured. Girard form class information for swampmahogany was obtained from a study made for the Experiment Station by Ralph E. Daehler of the Hawaii Division of Forestry. Board foot volumes were computed by the International 1/4 Inch Log Rule, using Hasel's volume table for second-growth redwood 2/. Form classes applied to each species were as follows: swampmahogany, 68; flooded-gum, 82; tropical ash, 74; and australian red-cedar, 78.

2/ Hasel, A. A. Board-foot and cubic-foot volume tables for second-growth redwood. U. S. Forest Serv. Calif. Forest and Range Expt. Sta. Forest Research Note 66, 14 pp. 1950.

A total of 76 plots was measured. Because all plots but one were collected in pairs, the number of stands sampled was 39. They included 8 swampmahogany locations, 10 flooded-gum locations, 12 tropical ash and 9 Australian red-cedar. At one flooded-gum location, it was found later that the two plots inadvertantly were located on plantings made in different years and these are each treated as a separate sample, making a total of 10 locations for flooded-gum.

Field work was conducted during August, September, and October, 1960.

RESULTS

VOLUME

The most board foot volume found at a single location (average of two 1/10-acre sample plots) was in a stand of swampmahogany eucalyptus. It was at the rate of 130 thousand board feet per acre (table 1). The average for all swampmahogany plots, 60 thousand board feet per acre, also was the highest average among the four species. However, swampmahogany stands were somewhat older on the average than flooded-gum eucalyptus, so that the former accumulated greater volumes. When data were converted to an annual growth rate to adjust for differences in age, flooded-gum had the highest single stand growth rate, 3,800 board feet per acre per year, and the highest average rate for one species, 2,100 board feet per acre per year. In comparison with the eucalypts, both the total volume per acre and the annual growth rates of tropical ash and Australian red-cedar were much lower (table 1).

A caution must be offered concerning the reliability of the growth and volume data that are mentioned above and that are presented in greater detail in table 1. They do not represent yields for whole stands nor for a typical cross-section of planted stands in Hawaii. They simply depict the growth on sample areas which were chosen as has been described in the section on methods. The yields should be interpreted as indicators of the potentialities for growth of forests in a rather wide variety of conditions on the island.

On the whole, the growth rates that were found are high in comparison to those of most important forest regions such as the continental United States. An even more encouraging feature is the early ages at which sawtimber size is attained. The plantings ranged in age from 21 years to 38 years. All of the stands contained trees that exceeded the minimum size set for sawtimber--11.0 inches diameter breast high.

The data derived from the field samples were too variable and too limited in range of ages to show the ages at which average rate of growth is maximum. Both eucalypts appeared to be thrifty and capable of continued high growth rates for somewhat longer periods. One of the two oldest swampmahogany plots had the highest rate of growth of any sample of this species. It was planted 38 years ago. The oldest flooded-gum plots were planted only 30 years before the examination. The growth rates of

Flooded-gum eucalyptus

81,000 board feet per acre

Age 21 years

Plot 12

tropical ash and red-cedar probably will remain the same or increase for a considerable period. In some stands, ingrowth (growth of smaller trees to the minimum diameter for sawtimber, 11.0 inches diameter breast high) will raise volume substantially in only a few years.

The proper age at which to harvest depends only partly upon when the average rate of growth culminates. It is also governed by the quality of growth (a condition that generally continues to improve for some years after the rate of increment in volume begins to decline), investment carrying charges, and risk of loss by destructive agents such as disease and wind.

Table 1.--Board-foot volume by species (in thousands of board feet)

Item	Swampmahogany eucalyptus	Flooded-gum eucalyptus	Tropical ash	Australian red-cedar
Highest volume per acre	130	94	38	30
Lowest volume per acre	18	3	2	4
Average volume per acre	60	52	14	17
Highest ann. growth rate per acre	3.4	3.8	1.2	1.2
Lowest ann. growth rate per acre	0.5	0.1	0.1	0.1
Average ann. growth rate per acre	1.8	2.1	0.5	0.6
Average age (years)	31	24	30	31

Full consideration of growth rates and most profitable time to harvest must take into account the effects of thinnings and intermediate harvest cuttings. Intermediate cuts probably would provide some revenue and prolong the period of vigorous growth. They also might increase the growth of higher value wood by making more room to grow for trees with better potential for quality growth. To determine the effects of such cuttings will require considerable experimentation and study.

Tropical ash

23, 000 board feet per acre

Age 30 years

Plot 70

Widely spaced tropical ash with very poor stem form

125 trees per acre

Plot 21

STOCKING

All of the plots had comparatively small numbers of trees owing partly to wide initial spacing and partly to mortality since the time of planting. The highest density of planting on the plots was 700 trees per acre and the lowest about 110 per acre. Survivals ranged from about 95 percent down to 50 percent. The highest and lowest number of live trees per acre on the plots were 460 and 95.

The average number of live trees per acre differed by species. Ash and red-cedar generally had fewer than the eucalypts.

Species	Live trees per acre
Swampmahogany eucalyptus	321
Flooded-gum eucalyptus	310
Tropical ash	202
Australian red-cedar	197

As a general rule, widely spaced trees tend to develop large, persistent branches closer to the ground and to grow more rapidly in stem diameter than more closely spaced trees. Hence, wider spacing stimulates trees to reach sawtimber size in fewer years, but at a sacrifice of usable length of limbfree, straight stem. A tendency to poor growth form was very conspicuous in the ash and red-cedar, and it may have resulted in part from the wide spacing. Another reason suggested by L. W. Bryan is that tropical ash grows very rapidly when young. This has caused the trees to "lodge" or bend over. The result has been forking and multiple stems which are formed at this stage. Between the eucalypts, swampmahogany exhibited stronger tendency than flooded-gum to respond to open spaces by producing heavier, more persistent branches.

Evidently, flooded-gum produces long, limb-free, straight stems. Swampmahogany has a slightly lesser tendency, then red-cedar, and ash the least. Quality of stems probably can be improved by forest management practices. One possibility is to space the trees closer at planting. Another is to thin out the less desirable trees in intermediate cuttings, in order to stimulate growth on the better quality trees. A third method is to use seed from parent trees which have proven ability to transmit superior growth habits to their progeny. Pruning, the removal of undesirable branches while they are small, is a fourth method. Probably a combination of all methods should be employed on ash and red-cedar.

Another possibility to improve stem form is to interplant trees of some other species that will overtop the ash or red-cedar somewhat but without severely crowding and suppressing them. This process occurs in many natural forests of mixed composition. Also, but only as a long-term project, search should be continued for other kinds of trees that have high value wood and better natural form.

The more closely spaced swampmahogany plots--8 x 8 feet or 8 x 10 feet with reasonably high survival--appeared to be stocked adequately to promote natural pruning and straight stems, but the widely spaced plots were not.

HEIGHT GROWTH

The height growth of flooded-gum eucalyptus can only be characterized as spectacular. At one location, the average height of dominants in a 21-year-old stand was 172 feet--an average annual rate of 8.2 feet. Not far from the two sample plots in this area, one tree was found that was 195 feet in height. Searching probably would have revealed even greater heights. Growth rates at the 10 locations ranged from 4.0 to 8.2 feet per year.

Swampmahogany eucalyptus grew only slightly less rapidly in height than flooded-gum. The rates ranged from 2.5 to 6.5 feet per year. The average height of dominants in the tallest stand was 179 feet at age 38 years.

Height growth of tropical ash ranged from 2.0 feet to 3.6 feet per year. At one location, 30-year-old trees averaged 109 feet.

In the poorest Australian red-cedar stand, at an elevation of 5,100 feet, height growth of dominants averaged only 1.2 feet per year. The other stands ranged from 2.0 to 4.8 feet per year. The tallest trees were 121 feet in a 25-year-old stand.

MORTALITY, DAMAGE, AND CULL

The standing dead trees and recently uprooted or broken trees on the sample areas made up only negligible percentages of the total trees tallied (table 2). The principal cause of death was suppression by more vigorous neighbor trees. Because the stands are very young, and spacings are comparatively wide, competition has not yet had much opportunity to kill the weaker trees.

Although many of the stands are exposed to strong winds, injury from this cause has been rather negligible. However, it is reported that in some areas which were not examined, wind injury has been very severe. In those areas, both uprooting and breaking of tops is said to have occurred. Most damage has occurred in eucalyptus stands. The ash and red-cedar have seldom been injured.

Cull was unimportant among the swampmahogany and flooded-gum trees in closed stands of the kind that were studied. But among the ash and red-cedar, cull losses in the form of crook, forking, and multiple tops was extensive. Actually, it is more extensive than the data in table 2 indicate. Many of the trees recorded as "live, sound," produced less usable bole material than if the trees had not contained forked or multiple stems.

Australian red-cedar

29, 000 board feet per acre

Age 25 years

Plot 76

Table 2.--Mortality, damage and cull by species

Species	All trees[1]	Condition			
		Live, sound	Dead[2]	Badly damaged[3]	Cull[4]
	Number	Percent			
Swampmahogany eucalyptus	514	96.4	0.6	2.0	1.0
Flooded-gum eucalyptus	534	97.2	0.2	0.6	2.0
Tropical ash	486	89.1	0.0	1.8	9.1
Australian red-cedar	235	92.3	0.4	1.3	6.0

1/ Includes all trees that were tallied on the plots--dead, living, sound, damaged and cull.

2/ Cause, chiefly suppression.

3/ Cause, chiefly breaking of tops and limbs by wind.

4/ Cause, chiefly severe lean, crook, forking and multiple stems.

RELATION OF GROWTH TO HABITAT

The local island foresters have gained a great deal of experience in planting trees over a period of many years. (For example, L. W. Bryan has resided on the island of Hawaii and directed the State's forestry program there since 1921.) Drawing on this experience, local foresters planted trees mainly on habitats that were believed to be suitable for each species. Consequently, the sites represented in this study do not sample all extremes of habitat. Conclusions as to suitability of habitats are limited.

ELEVATION

Elevation indirectly affects growing conditions chiefly because of its association with variations in atmospheric temperature. To some extent, elevation also is related to differences in rainfall. The distribution of sample areas by species and elevation was:

Species	Range in elevation (feet)
Swampmahogany eucalyptus	1,300-2,400
Flooded-gum eucalyptus	1,750-6,600
Tropical ash	1,550-6,250
Australian red-cedar	50-5,100

Within the range of elevations sampled, no consistent trends in annual rates of growth in board feet could be detected. The fastest growing swampmahogany was found at about 1,650 feet elevation, but the slowest growing plot also occurred at almost the same elevation. The best growth of flooded-gum occurred at about 3,150 feet, but very good growth also occurred at around 1,800 feet and 6,600 feet.

The best growth in board feet of tropical ash occurred at 5,000 feet, but a poor stand was found at almost the same elevation. The highest rate of growth of Australian red-cedar was found at 3,200 feet. A red-cedar plot at 5,000 feet showed exceptionally poor growth, but it was the only sample at an elevation greater than 3,300 feet; hence it cannot be regarded as conclusive evidence of a tendency toward poor growth at higher elevations Examination of basal area growth data, however, showed a more decided trend toward lower than average stocking by red-cedar at elevations greater than about 2,500 feet.

The analysis of growth in relation to elevation either supports or at least does not disagree with Carlson's and Bryan's 3/earlier conclusions that swampmahogany eucalyptus grows well up to 3,500 feet and flooded-gum eucalyptus at all elevations up to 6,000 feet; tropical ash grows well from near sea-level to 6,000 feet in elevation; Australian red-cedar grows best from sea-level up to 3,500 feet.

Rainfall

Average annual rainfall ranged from 45 inches to roughly 250 inches at the sample locations. All four species bracketed almost the full range.

Species	Range in average annual rainfall (inches)
Swampmahogany eucalyptus	75-250
Flooded-gum eucalyptus	45-250
Tropical ash	45-250
Australian red-cedar	75-210

Growth in relation to total annual rainfall was too variable to justify any conclusion that correlation exists. Apparently the lowest average annual rainfall on the study areas was sufficient to meet the requirements of the species and the highest rainfalls were within their tolerance. The possibility must be recognized of course, that additional moisture may be received from fog drip in some locations. In the lower rainfall areas, it may have considerable influence on plant life.

Soils and Drainage

Under the warm, humid conditions where the forest plantations are located, vegetational litter on the soil surface decomposes rapidly Mineral soil generally could be seen simply by parting the surface vegetation or scraping away recently deposited dead leaves All of the locations can be characterized as moist.

The surface soils ranged in color from almost black to reddish brown, greyish brown and yellowish brown. In structure, they varied from greasy or sticky when wet to friable and granular. In texture, they appeared to range from clay to silty loam. In a few instances gravel-size rocks were present. Larger surface rocks occurred on some areas

3/ Carlson, Norman K., and Bryan, L. W. Hawaiian timber for the coming generations. 112 pages, illus. Trustees of the Bernice P. Bishop Estate, Honolulu. 1959.

Depth to bedrock, the kind of underlying material--aa, pahoehoe, or cinders, and subsurface drainage were not determined with any degree of precision during the field examination of the trees. The soils series, and in some instances the phases, are being determined by the Soil Conservation Service. Although the information is not yet complete, the reports now at hand indicate rather clearly that soil depth and drainage are important factors in the growth of the trees.

Good drainage may result from any of several conditions, including slope of the land surface, a deep soil mantle, and permeable underlying aa or cinders, or a combination of two or more of these conditions. Level surfaces and shallow pahoehoe bedrock tend to create poor drainage. However, the topographic features, soil depths, and underlying rocks are highly variable within very short distances. Hence conditions for tree growth often differ greatly within exceedingly short distances. Consistent patterns of tree growth in relation to soil drainage could not be obtained from superficial examinations.

A few examples of the relation of growth to drainage conditions should be cited. The best growth of swampmahogany eucalyptus was found on a 30 to 35 percent slope, where drainage rather obviously must be good. The best growth of flooded-gum eucalyptus occurred on a very gentle slope 5 to 10 percent on a deep, well drained soil (Maile Series); the best tropical ash on slopes of 0 to 30 percent on a soil (Piihonua Series) that is described as deep and well-drained; and the best Australian red-cedar on a very gentle slope 5 to 10 percent on a soil (Honaunau Series) that is described as well drained with a depth to underlying pahoehoe lava typically 18 to 24 inches. In contrast, the poorest growth of swampmahogany was found on Kaiwiki Series soil that is described as "deep, well drained," but this planting was located on a very shallow, poorly drained phase. Some very poor growth of flooded-gum was found on soil of the Honokaa Series, which is described as deep and well drained, but evidently the site was represented by a poorly drained phase.

Another special case was the difference in growth of tropical ash between the two samples on Honaunau Forest. Data below are totals for 1/10-acre plots:

Plots	Trees (Number)	Basal area (Square feet)	Volume (Board feet)
73	44	32.3	2,905
74	42	16.4	388

These 1/10-acre plots were planted at the same time with the same stock on what appeared to be closely similar habitats. Yet for some unexplained reason the trees on plot 73 have produced almost twice as much basal area and 7 times as much board foot volume. The most obvious guess is that the soil under plot 74 is so shallow that growth has been severely retarded. This example illustrates how greatly productivity can fluctuate within very short distances without externally visible evidence as to the cause.

The plantings of each of the four species were situated on a considerable variety of soil and drainage conditions. On the average, the conditions under which each species was grown appeared to be about the same as for the other species except for the difference in elevations of planting. The variations in growth between species cannot be attributed to differences in any of the characteristics of soil and drainage that were observed. This investigation confirms the conclusion by Carlson and Bryan 4/ that swampmahogany and flooded-gum eucalypts, tropical ash, and Australian red-cedar are all well adapted to moist locations.

SUMMARY AND CONCLUSIONS

1. Among the 4 kinds of trees examined in Hawaii, flooded-gum eucalyptus produced both the greatest average yields--2,100 board feet per acre per year--and the highest individual stand yield--3,800 board feet per acre per year. Swampmahogany eucalyptus ranked second, with an average annual growth of 1,800 board feet per acre per year and a single-stand high of 3,400 board feet per acre per year. Australian red-cedar ranked third with an average of 600 board feet per acre per year and a maximum of 1,200. Tropical ash was fourth with an average of 500 and a maximum of 1,200 board feet per acre per year.

2. These yields were obtained in stands that had been planted from 21 to 38 years before they were measured. The ages at which maximum yields can be obtained cannot yet be determined, but the stands appear to be generally thrifty and continuing to grow at high rates. In some stands, thinning to improve quality or to stimulate growth may be desirable. Experiments to obtain quantitative information would be required.

3. The species appear to be well adapted to the sites in the great majority of cases.

4. Some reduction in the average spacing of swampmahogany should lessen the production of undesirable large, persistent branches. Spacing of 8 feet by 8 feet or 8 feet by 10 feet, which are now commonly used appear to be satisfactory.

5. An increase in the length of usable boles and a reduction in forking and multiple stems on ash and red-cedar is desirable. It may be caused by fast growth and bending in the juvenile stage that results in formation of new terminal shoots. Cultural practices and genetic methods may promote better stem form.

6. The yields that were found indicate very favorable potentialities for commercial production of timber in Hawaii.

4/ Loc. cit. p. 13.

Table 3.--Summary of statistical information from sample plots in plantations on the island of Hawaii, 1960

Plot number	Elevation (ft.)	Age [1] (yrs.)	Annual rainfall (in.)	Average height of dominants: Total (ft.)	Average height of dominants: Annual growth (ft.)	Volume per acre [2]: Total (M bd.ft.)	Volume per acre [2]: Annual growth (M bd. ft.)	Basal area per acre (sq. ft.)	Original spacing (ft.)	Trees per acre: Total (no.)	Trees per acre: Over 10.9" (no.)	Survival (percent)
					Swampmahogany eucalyptus							
1-2	1,300	30	250	145	4.8	31.9	1.1	241	10 X 16	195	145	80
57-58	1,400	38	210	179	4.7	101.6	2.7	511	8 X 8	405	220	63
61-62	1,500	37	175	93	2.5	18.3	0.5	222	8 X 12	315	145	72
51-52	1,650	38	250	146	3.8	130.2	3.4	800	10 X 10	325	260	75
71-72	1,850	30	100	136	4.5	82.6	2.8	450	8 X 10	360	155	73
13-14	2,000	23	110	149	6.5	31.7	1.4	256	8 X 12	285	145	68
49-50	2,000	30	250	130	4.3	47.0	1.6	376	8 X 8	460	180	72
31-32	2,400	25	75	150	6.0	35.0	1.4	303	12 X 12	225	155	92
					Flooded-gum eucalyptus							
3-4	1,750	24	250	146	6.1	53.4	2.2	198	12 X 12	185	100	65
47-48	2,000	30	250	174	5.8	94.1	3.1	281	12 X 12	275	170	88
7-8	2,150	22	100	89	4.0	11.8	0.5	114	10 X 20	175	75	85
17-18	2,250	23	100	142	6.2	61.1	2.7	292	8 X 12	345	210	88
15-16	2,500	23	85	98	4.3	3.2	0.1	102	10 X 12	255	30	70
9-10	2,600	21	100	162	7.7	68.2	3.2	288	10 X 10 [3]	355	160	90
11-12	3,150	21	80	139	6.6	80.9 [4]	3.8	298	8 X 12	300	175	80
39-40 [5]	4,100	30	125	153	5.1	86.3 [4]	2.9	365	10 X 10	357	175	82
35 [5]	6,600	21	45	172	8.2	37.4	1.8	276	8 X 10	460	160	80
36 [5]	6,600	25	45	100	4.0	22.1	0.9	203	8 X 10	400	100	80

1/ At end of 1960 growing season.
2/ Int. 1/4" Rule.
3/ Every other row is E. resinifera all of which is badly suppressed and below saw log size.
4/ Widely different volumes due to extreme difference in stand. Plot 39, 138.0; Plot 40, 34.0
5/ Single plot.

Table 3.--Summary of statistical information from sample plots

in plantations on the island of Hawaii, 1960

Page 2

Plot number	Elevation (ft.)	Age (yrs.)	Annual rainfall (in.)	Average height of dominants: Total (ft.)	Average height of dominants: Annual growth (ft.)	Volume per acre: Total (M bd.ft.)	Volume per acre: Annual growth (M. bd.ft.)	Basal area per acre (sq. ft.)	Original spacing (ft.)	Trees per acre: Total (no.)	Trees per acre: Over 10.9" (no.)	Survival (percent)
					Tropical ash							
5-6	1,550	30	250	75	2.5	5.6	0.2	138	12 X 12	140	75	50
53-54	1,650	27	250	54	2.0	16.0	0.6	190	10 X 12	290	160	80
69-70	1,700	30	100	109	3.6	23.2	0.8	342	7 X 10	460	210	72
55-56	1,850	28	210	56	2.0	2.6	0.1	77	16 X 16	130	45	80
21-22	1,950	28	100	58	2.1	2.3	0.1	149	16 X 16	125	50	82
25-26	2,000	28	100	110	3.9	20.4	0.7	282	16 X 16	165	140	95
29-30	2,750	28	75	96	3.4	12.4	0.4	162	20 X 20	95	75	90
73-74	3,150	32	75	95	3.0	16.5	0.5	243	10 X 10	430	105	95
67-68	4,950	30	125	58	1.9	7.1	0.2	216	16 X 20	115	65	75
43-44	5,000	32	125	100	3.1	37.9	1.2	332	12 X 20	160	145	92
27-28	5,500	31	60	90	2.9	20.1	0.6	259	12 X 20	160	110	85
37-38	6,250	23	45	53	2.3	3.6	0.2	85	12 X 20	160	35	90
					Australian red-cedar							
63-64	50	38	185	77	2.0	29.6	0.8	236	16 X 20	115	100	85
59-60	1,400	38	210	76	2.0	7.8	0.2	114	12 X 12	200	60	67
65-66	1,700	30	100	100	3.3	21.2	0.7	240	8 X 10	415	115	85
19-20	1,800	30	100	84	2.6	10.9	0.4	143	12 X 12	230	80	70
23-24	2,050	30	100	94	3.1	11.4	0.4	229	12 X 20	140	120	85
33-34	2,500	28	75	98	3.5	17.0	0.6	161	15 X 15	155	110	85
75-76	3,150	25	75	121	4.8	29.2	1.2	194	10 X 10	275	115	74
41-42	3,300	30	140	93	3.1	20.1	0.7	163	16 X 20	125	75	85
45-46	5,100	32	125	38	1.2	3.9	0.1	97	16 X 20 6/	120	70	90

6/ Very scattered.

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